Ecological Assessment, Conservation and Management of Surajpur Wetland, Greater Noida, Uttar Pradesh

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Introduction

Wetland is a generic term for water bodies of various types, and includes diverse hydrological entities, namely, lakes, marshes, swamps, estuaries, tidal flats, river flood plains and mangroves. According to Ramsar Convention on wetlands (1971), *'Wetlands are areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salty, including areas of marine water; the depth of which at low tide does not exceed six meters'*. Ecologically, wetlands have been defined as ecotones or transitional zones between permanently aquatic and dry terrestrial ecosystems. Long regarded as wastelands, wetlands are today recognized as important feature in the landscape that provides numerous beneficial services (Jha and Chaudhary 2011). They are one of the most productive ecosystems and rank with the tropical rain forests (Cross and Vohs 1998). Their productivity lies in the nature of biodiversity they harbor and the frequency of transfer of energy from one to another organism (Jha and Chaudhary 2011).

A survey by Space Application Centre (SAC) during 2011 using remote sensing techniques identified the total of 23,890 wetlands in the state. In addition 97,352 smaller wetlands have also been identified. Total wetland area estimated is 12,42,530 ha; this is around 5.16% of the geographic area of the state (Table 1). Detailed ecological studies on the wetlands of Uttar Pradesh are scanty. Examples of major works are; Anon. (1998-99), Choudhary *et al.* (2002), Pathak *et al.* (2004), Khoiyangbam *et al.* (2007), Varghese *et al.* (2008), Bhat *et al.* (2009), Manral (2009), UPSAC (2010), Kumar and Srivastava (2011), Bahera *et al.* (2012) and Hussain *et al.* (2012).

The concept of urban wetlands, though in its nascent stage describes urban wetlands that have soils that are saturated with water or flooded with shallow water that support rooted floating or emergent aquatic vegetation (Baldwin *et al.* 2007). Through the ages, urban wetlands have been the lifeline of most cities in India. They are found all over the country and are either natural or have been built. Urban wetlands provide multiple values for suburban and city dwellers (Castelle *et al.* 1994). The capacity of a functional urban wetland in flood control, aquatic life support, and as pollution sink implies a greater degree of protection. Surajpur wetland forms an unique conservation area in the urban domain of Greater Noida town located in the Gautam Buddh district. Since the region is being developed into fast paced townships the close proximity to wetlands can enhance the green area of the region. The wetland provides an opportunity to protect biodiversity and set

Table 1 : Area estimates of wetlands in Uttar Pradesh.

Wetland category	Number of wetlands	Total wetland area (ha)	Wetland area (%)	Open water area (ha)	
				Post-monsoon area	Pre-monsoon area
Inland Wetlands- Natural					
Lakes/Ponds	3684	122531	9.86	42276	32030
Ox-bow lakes/Cut-off meanders	1672	51371	4.13	22104	14422
High altitude wetlands	-	-	-	-	-
Riverine wetlands	1638	61100	4.92	34229	16968
Waterlogged	3951	76263	6.14	41211	21227
Rivers/Stream	1278	607315	48.88	376712	315457
Inland Wetlands- Man-made					
Reservoirs/Barrages	1608	105641	8.5	100309	62883
Tanks/Ponds	5441	33263	2.68	19483	11410
Waterlogged	4618	87694	7.06	53892	20597
Salt-pans	-	-	-	-	-
Sub-Total	**23890**	**1145178**	**92.17**	**690216**	**494994**
Wetlands (<2.25 ha)	97352	97352	7.83	-	-
Total	**757060**	**15260572**	**100**	**8600798**	**5801220**

Source: *Space Application Centre, Hyderabad, Ministry of Environment & Forests, Govt. of India (2011).*

an example of how wildlife can be protected and preserved close to urban areas, without hindering the development of the same. It will not only provide people an opportunity to experience the uniqueness of the area and the species it attracts, but also make them more environmentally conscious. Within this purview, Uttar Pradesh Forest Department and the Greater Noida Authority in collaboration with WWF-India conducted a lead project during March 2010 to February 2013 on the planning and development of this conservation area.

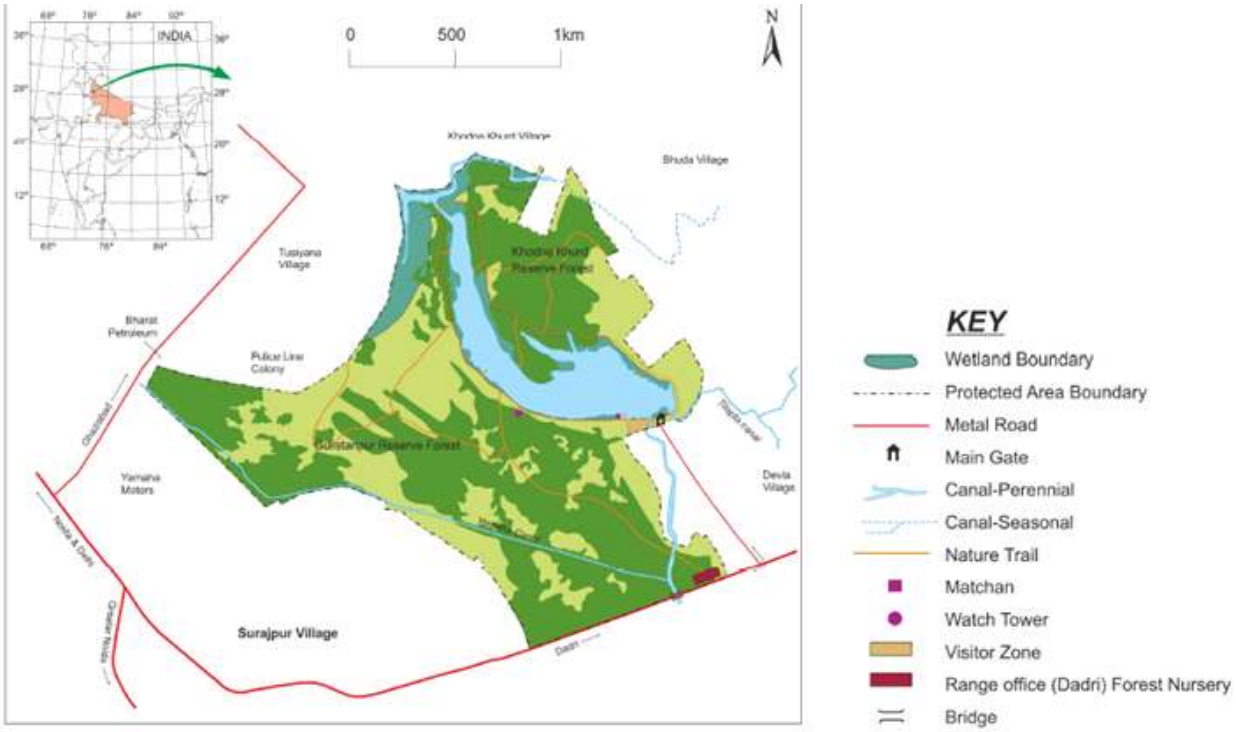
Study Area

Surajpur wetland (28°31.425'N; 77°29.714'E) is an excellent example of an urban wetland restoration in Yamuna River basin and is situated in Dadri Tehsil of District Gautam Budh Nagar, Uttar Pradesh (Figure 1). The wetland falls in the Gangetic Plain Biogeographic Zone (Rodgers *et al*. 2002) at an elevation of 184.7m above MSL. The area is reserve forest and spreads over 308 hectare (3.08 km^2) that includes 60 hectare (0.60km2) of natural wetland. The terrain of the area is almost plain, although the tract divides the area into flat terrestrial form and deep wetland area. The lake area has fine grained soil called lacustrine soil and supports tropical moist and dry deciduous vegetation (Champian and Seth 1968). Surajpur wetland is mainly rain-fed. Other sources for water recharge are catchment area of Hawaliya drain which is attached to Hindon River and the irrigation canal of Tilapta Minor, which originates from Kulesra Bund Hindon River.

Methodology

Data collection

Flora : On the basis of dominant floristic composition



Habitat	Wetland	Woodland	Grassland	Marshland
Area (Ha)	32	152	96	28
Percentage (%)	10.39	49.35	31.16	9.09

Figure 1. Habitat map of the study area

the study area was categorized into 3 major habitats: Woodland, Grassland and Wetland. Intensive floristic surveys were made and plant specimens were collected to prepare a comprehensive herbarium following Jain and Rao (1977) and Singh and Subramaniam (2008). Bentham and Hooker's Natural system of classification was followed to classify the species. A total of 52 circular plots of 10m radius were laid in the woodland habitat. 4 plots in *Terminalia arjuna*, 8 plots in *Sygygium cumunii* and 20 plots in each *Phoenix sylvestris* and *Prosopis juliflora* habitats respectively. Shrubs were sampled with in 3m radius while herbs in 0.5m × 0.5m quadrate. In each sampled plot, name of plant species and number of individuals were recorded. Grasses were sampled in 0.5m × 0.5m quadrate. Name, number of species and number of individuals were recorded within each plot. Aquatic macrophytes were sampled by stratifying the wetland into 3 blocks. Hydrophytic plants were further divided into 5 subtypes on the basis of their habitat and adaptation, Emergent (rooted erect herbs stand above the level of water), Rooted- floating (aquatic herbs floating or creeping), Submerged (rooted aquatic plants totally submerged in water), Free-floating (plants which are not rooted, their roots are suspended in water) and Amphibious (plants living partially in water and partially above the surface of water) (Vijayan 1983). The wetland was stratified largely on the basis of water depth. Quadrate plots of 0.5m × 0.5m were laid randomly in each stratum. Within the sampled plot, name of plant species, number of individuals was recorded.

Fauna : Data on avifauna in the terrestrial habitats (Woodland and Grassland) was collected on monthly basis by systematically walking on fixed routes while observations on water birds were made from 3 vantage points selected in respective wetland block to facilitate easy count. Observations were made from 0600 to 1000 hr and from 1600 to 1800 hr. 10 'X' Nikon binoculars were used for sighting birds and the species were confirmed

by consulting standard field guides (Grimmet and Inskipp 2000). Birds seen were recorded along with habitat type, season and frequency of occurrence (Kumar and Gupta 2009). The nomenclature (Common and Scientific names) follows Rasmussen *et. al.* (2012). The status of birds was categorized as resident (R), winter migrant (WM), summer migrant (SM), and passage migrant (PM) after Rasmussen and Anderton (2012). Abundance category was assigned as abundant (A), common (C) and Uncommon (U) according to the frequency of occurrence. For density estimates of bird species, Point Count sampling (Javed and Kaul 2002) was conducted in Woodland and Grassland habitat respectively while Total Count sampling as described by Urfi *et al.* (2005) was used for the wetland habitat. Fishes were caught on monthly basis through cast net method as described by Hayes (1996). Identification was done by consulting experts, local fisherman and consulting standard field manuals, for eg. Heda (2009) and (Jayaram 2012). Specimens of fishes have been preserved in 10% Formaldehyde solution (Kline 2001) in plastic jars for record. Ad-libitum records (Altmann 1974) were kept for mammals, butterflies and amphibians and reptiles. Identification for mammals was made following Prater (1971), for butterflies identification was made by referring Kehimkar (2008). Amphibians and reptiles were identified following Daniel (2002) and Datta (2008).

Data analyses : Overall mean density estimates were calculated for respective habitats for flora, following Dombois and Ellenberg (1974). Density was calculated as;

D = n / a; Where D = density, n = total number of individuals and a = area of the quadrate

To quantify species diversity **Shannon Diversity Index** and **Marglef's Richness Index** were used. SPECDIVER. EXE programme was used for calculations.

Shannon-Weinner's Diversity Index: 'H' = Σ pi log pi; Where Pi is the proportion of species i calculated as proportion of the total no. of individuals of all the species.

Margaleffs Species Richness Index: RI = S-1/n Log n; Where S = No. of species and n = No. of individuals.

Results

Plant species composition and floral diversity in Surajpur wetland

During the study 228 species of angiosperms belonging to 190 genera and 68 families were recorded. Out of 228 plant species, 184 species belonging to 57 families are dicotyledons while 41 species belonging to 8 families are monocotyledons. Pteridophytes recorded only 3 species (Table 2). The dominant plant families recorded are Asteraceae, Fabaceae, Convulvulaceae, Poaceae and Cyperaceae. The different life-forms of plant species recorded were 163 herbs, 36 trees, 18 climbers and 11 shrubs (Table 3). Of the 46 aquatic plant species recorded, 16 were amphibious, 21 were emergent, 4 were rooted-floating, 3 were submerged and 2 were free-floating respectively.

Table 2. Floristic composition of the study area.

Groups	Family	Genera	Species
Dicotyledons	57	154	184
Monocotyledons	8	33	41
Pteridophytes	3	3	3
Total	68	190	228

Table 3. Life-form of plant species of Surajpur wetland.

Life-form	Number recorded
Climber	18
Herb	163
Shrub	11
Tree	36

Vegetation density, diversity and richness in different habitats

The overall mean tree density in woodland habitat was recorded as 1438 ha-1. *Terminalia arjuna* recorded the maximum density 477.71 ha-^{1} while *Prosopis juliflora* recorded the least density 189.49 ha-^{1}. The overall mean shrub density recorded in woodland habitat was 6690.84 ha-^{1}. The overall mean herb density recorded in

woodland habitat was 52.90 m-^{2}. The overall mean Grass/Sedge density recorded in woodland habitat was 166.38 m-^{2}. Margalef's Species Richness Index was estimated as 4.72 while the Shannon-Wiener's Diversity Index was estimated as 0.98 for the woodland habitat (Table 4).

Grass/Sedge density in grassland habitat was recorded as 112.6 m-2. Desmostachya bipinnata recorded maximum density 149.78 m-2 while Saccharum ravennae recorded least density 0.57 m-2. Chenopodium album was the only herb species recorded in the grassland habitat and its density was 1.60 m-2. Margaleffs Species Richness Index was estimated as 0.80 while the Shannon-Weinner's Diversity Index was estimated as 0.40 for the grassland habitat (Table 4).

Herb density in wetland habitat was recorded as 83.56 m-^{2}. *Alternanthera philoxeroides* recorded maximum density 26.20 m-^{2} while *Ranunculus sceleratus* and *Ceratophyllum demersum* recorded least density 0.08 m-2 respectively. Grass density in wetland habitat was recorded as 35.44 m-^{2}. *Paspalum distichum* recorded maximum density 35.32 m-^{2} and *Cynodon dactylon* recorded least density 0.12 m-^{2}. Margaleffs Species Richness Index was estimated as 1.50 while the Shannon-Weinner's Diversity Index was estimated as 0.75 for the wetland habitat (Table 4).

Table 4. Diversity Indices for different habitats in the Surajpur wetland

Habitat	No. of Species	Diversity Indices	
		Margalef's Richness (S)	Shannon Diversity (H′)
Woodland	40	4.72	0.98
Grassland	6	0.80	0.40
Wetland	13	1.50	0.75

Fauna

Faunal diversity in Surajpur wetland

Surajpur wetland is a mosaic of habitat supporting indigenous and threatened faunal diversity. During the study period a total of 6 species of mammals, 186 species of birds, 13 species of herpeto-fauna, 15 species of fishes and 52 species of butterflies were recorded (Table 5).

Table 5. Overview of biodiversity recorded in Surajpur wetland.

Group	Family	Genus	Species
Mammal	6	6	6
Avifauna	44	134	186
Herpetofauna	10	13	13
Piscifauna	10	13	15
Butterflies	5	35	52

Avifaunal composition in Surajpur wetland

During the study 186 species of birds belonging to 44 families were recorded, wherein Muscicapidae recorded the maximum number of 29 species. Out of 186 bird species 59% (n=113) were resident, 26% (n=49) were winter migrant, 14% (n=26) were summer migrant and 1% (n=2) were passage migrant. Species occurrence was recorded as abundant 34% (n=63), common 42% (n=79) and 24% (n=44) as uncommon. A remarkable variation in the total count of wintering birds was recorded between 2010 and 2013 during the months from November to February each year (Figure 2).

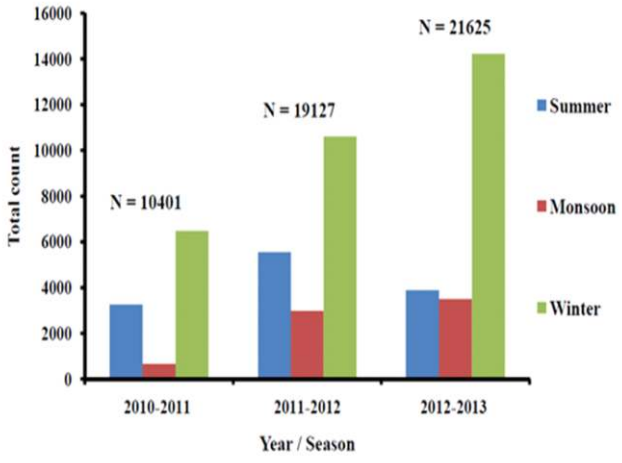


Figure 2. Water bird count recorded across the seasons over the three year study period

Conservation Management and General Discussion

Wetland management generally involves activities that can be conducted within and around wetlands to protect, restore, control, or provide for their functions and values keeping the ecological integrity intact. Wetlands are especially critical habitats for wildlife, and exceed all other land types in wildlife productivity (Payne 1992). Urbanization is a frequently cited cause of species endangerment in various parts of the world (Czech and Krausman 1997), but our understanding of the ecology of urban systems and how best to manage them for the needs of both humans and wildlife is limited (McDonnell and Pickett 1990). In India, several studies have focused on changes in bird populations and distribution in natural habitats (Urfi *et al*. 2005 and Urfi 2006), but very few have attempted to investigate the impacts of urbanization on birds. However, many Indian cities offer foraging and nesting habitats for birds, especially colonial waterbirds such as egrets, herons, cormorants, storks, ibis, spoonbills and pelicans. More than 45% of all heronries in India are located in parks and gardens in urban areas (Subramanya 1996). Additionally, Important Bird Area's (IBAs) affording sizeable populations of resident and wintering waterfowl exist on rivers within several cities. Whether protected or otherwise, such patches of wilderness are usually the first victims of urban expansion and may end up as habitat islands in a sea of concrete (Urfi 2006).

WWF-India was instrumental in conducting ecological studies monitoring changes in species composition (flora and fauna) across seasons over the study years. Based on the findings, following technical inputs were provided for wetland habitat restoration.

1. Raising of embankment along the water body

The embankment along the water body was raised at a height of 1.25 m and widen to 2m. This not only serves as a nature trail but has also helped in delineating areas (micro-habitat) with varying levels of water depth. Plant occurrence and distribution are determined by water depth, and in turn dictate the types of animals that use the wetland. Wildlife selects the vegetative zone created by the water depth that best provides for their needs such as food and nesting. Diving ducks feed on submergent vegetation in the deeper, more open water areas; dabbling ducks feed off the surface in the more shallow zones; and shorebirds use the exposed mud flats. The ideal type of wetland for wildlife is a hemi-marsh, one that is 50% open water and 50% vegetation. Water level management improves the attractiveness of a wetland to wildlife throughout the year. Stagnant water conditions usually produce monoculture vegetation which results in reduced wildlife use and diversity. However, artificial water level fluctuations must duplicate natural wetland drawdown and flooding cycles.

2. Removal of harmful aquatic weeds

Water Hyacinth *Eichornia crassipes* and Alligator Weed *Alternanthera philoxeroides* have been recorded as harmful aquatic weeds. They disrupt the aquatic environments by blanketing the surface of the water impeding penetration of light, gaseous exchange (sometimes leading to anaerobic conditions) with adverse affects on flora and fauna. Their encroachment in the wetland has been checked through manual removal particularly before the onset of winters in order to maintain larger open areas for wintering birds, although surveillance and early detection is important for controlling their infestation.

3. Plantation of indigenous fruiting trees

Indigenous fruiting tress such as *Ficus* sp., *Terminalia arjuna*, *Syzygium cumini*, *Acacia* sp., *Bauhinia* sp., *Cordia dichotoma*, *Grewia asiatica*, *Emblica officinialis* and *Phyllanthus reticulatus* have been planted which have helped in attracting bird species thus increasing diversity. To maintain dense bushes under storey plants such as *Carissa carandas*, *Bambusa* sp. and *Capparis* sp. have also been planted. *Vegetated riparian* buffers stabilize stream banks and check erosion.

4. Creation of mounds in the wetland area

Scrap of Water Hyacinth was collected as heap in the wetland area and trees like *Acacia* sp. were planted to encourage formation of heronries.

5. Location for erecting watch towers and demarcation of nature trails

Watch towers have been erected on the embankment along the water body in two directions, south and southwest. It provides an opportunity of aerial view of the landscape and sighting of birds from close

range without disturbing them. Nature trails have also been demarcated in the woodland habitat of *Prosopis juliflora* and *Phoenix sylvestris* respectively. These are 0.5 km in length and are well interconnected starting from the entrance point at the Forest Nursery. Signages depicting the avifaunal assemblage of Surajpur wetland have been developed and displayed along the nature trails.

6. *Conservation education awareness and capacity building programmes*

Biodiversity conservation is inextricably linked with education and awareness and capacity building aiming to improve the relationship of local people with their natural environment. This involves knowledge-sharing, promoting research and monitoring, education and training, and participatory decision-making with innovate and demonstrative approaches to reconcile conservation and sustainable development based on sound science and local communities efforts.

On occasions such as World Wetlands Day (2nd February) and Wildlife Week (1st–7th October) education and awareness programmes were conducted. Several schools from Delhi NCR actively participated.

Two bird census workshops were organized for the frontline forest staff. They were given lectures on general aspects of biodiversity conservation and field training in use of field equipments for data collection. Field exercises were held to make understand data collection methodologies such as Point Count, Total Count and Transect Count.

7. *Publication of awareness raising materials*

Publications play an effective role in awareness raising and in outreach to deliver extension messages and generate feedback to the project. The project produced communication materials such as booklet on bird checklist, a brochure and a poster on general biodiversity of Surajpur wetland.

8. *Way forward*

Surajpur wetland can be described as a mosaic of habitats and serves as a safe haven for several threatened flora and fauna found in the region. The study demonstrates the potential for biodiversity conservation by building a striking harmonious synergy between cause of conservation and the aspirations of urban/

Poster on general biodiversity of Surajpur Wetland

development expansion. It is proposed that ecological monitoring and outreach programmes for conservation awareness must remain continued. Of the approx. 1300 avian species recorded in India, more than 10% have been recorded here. The wetland holds immense potential of being declared as an Important Bird Area (IBA) of conservation importance. Create and commit to implementing a long-term (at least 10-year) conservation management plan for the existing restored on-site native habitats, water bodies, and their buffers and create a guaranteed funding source for management.

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